# PATENT ABSTRACTS OF JAPAN

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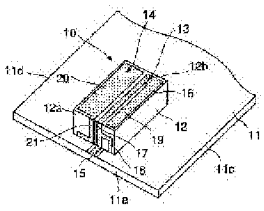
(71)Applicant : MURATA MFG CO LTD
(72)Inventor : ONAKA KENGO
ISHIHARA TAKASHI
SATO HITOSHI
NAGUMO SHOJI

(54) RADIO COMMUNICATION APPARATUS




(57)Abstract:

PROBLEM TO BE SOLVED: To ensure a sufficient frequency bandwidth while holding the operation of a surface-mounted antenna stably.
SOLUTION: A surface-mounted antenna 10 is composed of a feed element 13 and a passive element 14 formed on the surface of a dielectric base. The feed element 13 includes a feed radiation electrode 16 and a feed electrode 17. The passive element 14 includes a passive radiation electrode 20 and a ground electrode 21. The feed and passive elements 13, 14 make a double resonance. The antenna 10 is mounted with the feed electrode 17 and the ground electrode 21 located approximately at the center of the end side 11a of a circuit board 11.

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CLAIMS

[Claim(s)]
[Claim 1] In wireless radios equipped with the surface mount mold antenna which has an electric supply component and at least one passive element, and the circuit board which installs this antenna, while double-resonating said electric supply component and said passive element of said antenna Wireless radios characterized by a substrate current [ in / for the current concentration part of said antenna which the current which flows to said electric supply component and said passive element concentrates most / said circuit board ] arranging said current concentration part in the location where the die length of the edge side which flows to the opposite sense as an origin becomes almost equal.
[Claim 2] The electric supply component containing the electric supply electrode connected to the electric supply radiation electrode and this electric supply radiation electrode on the front face of the base of a dielectric, A surface mount mold antenna equipped with at least one passive element containing the grand electrode connected to the non-supplied electric power radiation electrode and this non-supplied electric power radiation electrode, In wireless radios equipped with the circuit board of the rectangle which installs this antenna, while double-resonating said electric supply component and said passive element Wireless radios characterized by arranging said electric supply electrode and said grand electrode of said antenna in the abbreviation center section of any one edge side of said circuit board.
[Claim 3] The electric supply component which contains the electric supply electrode which carries out capacity coupling to said electric supply radiation electrode in the grand electrode list connected to the electric supply radiation electrode and this electric supply radiation electrode on the front face of the base of a dielectric, The surface mount mold antenna which has at least one passive element containing the grand electrode connected to the non-supplied electric power radiation electrode and this non-supplied electric power radiation electrode, Wireless radios characterized by arranging said both grand electrode of said antenna in the abbreviation center section of any one edge side of said circuit board in wireless radios equipped with the circuit board of the rectangle which installs this antenna while double-resonating said electric supply component and said passive element.
[Claim 4] Wireless radios according to claim 1, 2, or 3 characterized by double-resonating the resonance frequency of said passive element with the resonance frequency of the 2nd higher harmonic of said electric

supply component while resonating said electric supply component on the frequency of a fundamental wave, and the frequency of the 2nd higher harmonic.
[Claim 5] Wireless radios of any one publication of claim 1 characterized by the boundary length which met the edge side of said circuit board being the die length lambda / more than two (however, lambda wavelength of the fundamental wave of an operating frequency) thru/or claim 4.
[Claim 6] Wireless radios of any one publication of claim 1 characterized by installing said antenna in this grand conductor side while preparing a grand conductor side in said circuit board thru/or claim 5.

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[Translation done.]

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to wireless radios and the wireless radios which mounted the surface mount mold antenna in the circuit board especially.
[0002]
[Background of the Invention] Although the miniaturization of mobile transmitters, such as a portable telephone, is progressing in recent years, handling of an antenna part may become have projected to the exterior of a mobile transmitter in many cases, and inconvenient. In order to cancel such inconvenience, the mobile transmitter which held the antenna in the interior of a case completely is marketed. In this mobile transmitter, as shown in drawing 11 , the surface mount mold antenna 1 is mounted on the circuit board 2, for example. And the

transceiver circuit (RF circuit) of radio frequency and the digital disposal circuit of baseband are formed in the circuit board 2.
[0003] As the above surface mount mold antennas 1 are shown in drawing 12 , the radiation electrode 4 is formed in the front principal plane of the base 3 of a dielectric, and the earth electrode which is not illustrated is formed in the flesh-side principal plane. The electric supply electrode 5 is connected to the radiation electrode 4 using the side face of a base 3, and electric power is supplied by the radiation electrode 4 from RF circuit through this electric supply electrode 5. If the surface mount mold antenna 1 is mounted in the circuit board 2, since it will become easy to combine the electric field of the surface mount mold antenna 1 with the touch-down potential of the circuit board 2, Q of the surface mount mold antenna 1 becomes large, and frequency bandwidth becomes narrow. From this, the surface mount mold antenna 1 is brought near and installed in a part for the corner of the circuit board 2.
[0004] If the surface mount mold antenna 1 is excited, while the substrate currents 6 and 7 will flow to the circuit board 2 along with the edge side, and the circuit board 2 will act on it like some surface mount mold antennas 1, enlarging radiation resistance on the appearance of the surface mount mold antenna 1 and making gain of an antenna high, sufficient bandwidth is obtained in the frequency band of the surface mount mold antenna 1.
[0005]
[Problem(s) to be Solved by the Invention] However, when the substrate currents 6 and 7 flow to the circuit board 2, the electromagnetic field by the substrate currents 6 and 7 occur also on the background of the circuit board 2 of the part in which the surface mount mold antenna 1 was installed. For this reason, depending on the method of handling of the wireless radios by the user, it was influenced of the user, and there was a possibility that about one surface mount mold antenna electromagnetic field might affect actuation of turbulence and surface mount mold antenna 1 self.
[0006] It is in offering the wireless radios which this invention was accomplished in order to solve an above-mentioned technical problem, the purpose secured sufficient frequency bandwidth in a surface mount mold antenna, and carried out actuation of an antenna to stability.
[0007]
[Means for Solving the Problem] This invention is made into a means to solve a technical problem with the configuration shown below in order to attain the above-mentioned purpose. That is, the wireless radios of the

1st invention are equipped with the surface mount mold antenna which has an electric supply component and at least one passive element, and the circuit board which installs this antenna. While double-resonating the electric supply component and passive element of a surface mount mold antenna as a description, it is considering as a means to solve a technical problem with the configuration to which the die length of the edge side to which a substrate current [ in / for the part of the antenna which the current which flows to an electric supply component and a passive element concentrates most / the circuit board ] flows to the opposite sense considering a current concentration part as an origin arranges in the location which becomes almost equal.

[0008] In above-mentioned invention, if a surface mount mold antenna is excited, to the circuit board which installed the surface mount mold antenna, a substrate current will flow with a current concentration part as the starting point. Since the die length of the edge side which flows to the opposite sense among the substrate currents which flow to the circuit board is arranged in the location which becomes almost equal, the part which a current concentrates most a surface mount mold antenna While the substrate current of the reverse sense flows right and left among surface mount mold antennas with the part as the starting point to which a current becomes the strongest in the edge side in which the surface mount mold antenna was installed If it puts in another way, along with one edge side of the circuit board, the die length of the distance in which the substrate current of the reverse sense is flowing, and the edge side to which a substrate current flows to the reverse sense will become almost equal.

[0009] For this reason, in the edge side of the circuit board in which the surface mount mold antenna was installed, the electromagnetic field generated according to a substrate current are offset, or are decreased. If it puts in another way, even if the electromagnetic field by the substrate current do not exist or it exists near the antenna, it will become very weak electromagnetic field. Therefore, it is not necessary to take into consideration near the antenna turbulence of the electromagnetic field produced under the effect of a user, and the own property of a surface mount mold antenna is stable. In this case, even if it sets, in the edge side of the circuit board which is separated from a surface mount mold antenna, the edge side to which the substrate current of the same direction flows operates as some antennas.

[0010] Moreover, since the electric supply component and passive element which constitute a surface mount mold antenna will be double-resonated in the same frequency band and frequency bandwidth will be extended

although the frequency bandwidth of a surface mount mold antenna becomes narrow if a surface mount mold antenna is brought near and installed in the abbreviation center section of the edge side of the circuit board from a part for the corner of the circuit board, for example, the bandwidth of sufficient size is securable.

[0011] The wireless radios of the 2nd invention are equipped with the circuit board of the rectangle which installs a surface mount mold antenna equipped with the electric supply component containing the electric supply electrode connected to an electric supply radiation electrode and this electric supply radiation electrode, and at least one passive element containing the grand electrode connected to a non-supplied electric power radiation electrode and this non-supplied electric power radiation electrode, and this antenna in the front face of the base of a dielectric. As a description, while double-resonating an electric supply component and a passive element, it constitutes arranging the electric supply electrode and grand electrode of a surface mount mold antenna in the abbreviation center section of any one edge side of the circuit board as a description.

[0012] According to this invention, the parts of the amount of currents of an electric supply electrode and a grand electrode increase most among surface mount mold antennas, but since a surface mount mold antenna is installed so that an electric supply electrode and a grand electrode may be brought near by the abbreviation center section of one side of the circuit board and may be arranged towards the substrate edge of the circuit board, the electromagnetic field which generate the nearness of a surface mount mold antenna according to the flowing substrate current among the substrate currents which flow to the circuit board are offset. Therefore, near the antenna, the turbulence of the electromagnetic field by the substrate current resulting from an external factor is not produced. Also in this case, the electromagnetic field which generate the edge side of the circuit board according to the substrate current which flows to the same direction turn into some electromagnetic fields emitted from a surface mount mold antenna.

[0013] Moreover, a surface mount mold antenna can be constituted as an antenna of a single band, and an electric supply component is constituted so that it may resonate in one frequency band. In this case, it can consider as the surface mount mold antenna of a broadband by double-resonating the resonance frequency of a passive element with the resonance frequency of an electric supply component.

[0014] Furthermore, a surface mount mold antenna can also be constituted as an antenna of a DEYUARU band. At this time, an electric supply

component is constituted so that it may resonate on the frequency of a fundamental wave, and the frequency of a high order higher harmonic. For example, when a good return loss property is not acquired in one of resonance frequency among the frequency of a fundamental wave, and the frequency of a high order higher harmonic, the resonance frequency and resonance frequency of a passive element are double-resonated, and return loss is improved. Of course, when the return loss of an electric supply component double-resonates good resonance frequency and the resonance frequency of other passive elements, it is also possible to extend the bandwidth of the frequency band where the resonance frequency belongs.

[0015] The wireless radios of the 3rd invention have the surface mount mold antenna which it has in the electric-supply component which contains the electric-supply electrode which carries out capacity coupling to an electric-supply radiation electrode in the grand electrode list connected to an electric-supply radiation electrode and this electric-supply radiation electrode on the front face of the base of a dielectric, and at least one passive element containing the grand electrode connected to a non-supplied electric power radiation electrode and this non-supplied electric power radiation electrode, and the circuit board of the rectangle install this antenna. As a description, while double-resonating an electric supply component and a passive element, it constitutes arranging both the grand electrode of a surface mount mold antenna in the abbreviation center section of any one edge side of the circuit board as a description.

[0016] According to this invention, since it is constituted as a capacity electric supply component which grounded the end of an electric supply radiation electrode, the grand electrode of the electric supply component which a current concentrates in a surface mount mold antenna is brought near by the abbreviation center section of the edge side of the circuit board with the grand electrode of the passive element which a current concentrates similarly, and an electric supply component is brought close to the substrate edge of the circuit board, and is arranged. Although the substrate current of the reverse sense flows right and left also in this antenna from the parts of the grand electrode of an electric supply component, and the grand electrode of a passive element, since a substrate current is mutually negated if close to a surface mount mold antenna, the turbulence of the electromagnetic field by the substrate current is not produced [ near the antenna ].

[0017] The surface mount mold antenna in above-mentioned invention can also be constituted as the antenna of a single band, and an antenna of a

DEYUARU band, and a surface mount mold antenna can open it for frequency bandwidth to about 2 times by double-resonating an electric supply component and a passive element in the narrow frequency band of frequency bandwidth. [ as well as the 2nd invention ]
[0018] In above-mentioned invention [ which ], the wireless radios of the 4th invention are constituted [ double-resonating the resonance frequency of a passive element with the resonance frequency of the 2nd higher harmonic of an electric supply component, and ] as a description while resonating an electric supply component on the frequency of a fundamental wave, and the frequency of the 2nd higher harmonic.
[0019] Although the optimal adjustment of return loss is acquired in the frequency of a fundamental wave by adoption of this configuration, when it becomes poor having consistency return loss, on the frequency of the 2nd higher harmonic, poor adjustment of the return loss in the frequency of the 2nd higher harmonic is improved in the frequency band where the frequency of the 2nd higher harmonic belongs by double-resonating the resonance frequency of a passive element with the frequency of the 2nd higher harmonic of an electric supply component. Thereby, a surface mount mold antenna turns into the so-called antenna of a DEYUARU band with two frequency bands.
[0020] The wireless radios of the 5th invention are constituted in above-mentioned invention [ which ] considering the boundary length which met the edge side of the circuit board being the die length lambda / more than two (however, lambda wavelength of the fundamental wave of an operating frequency) as a description.
[0021] The electromagnetic field generated by this configuration based on the substrate current of the same direction which flows to the circuit board turn into some electromagnetic fields emitted from a surface mount mold antenna, and contribute to radiation of the electromagnetic wave emitted from a surface mount mold antenna.
[0022] In above-mentioned invention [ which ], the wireless radios of the 6th invention are constituted considering installing a surface mount mold antenna in this grand conductor side as a description while preparing a grand conductor side in the circuit board.
[0023] By adoption of this configuration, the stray capacity value between the electric supply radiation electrode and non-supplied electric power radiation electrode which constitute a surface mount mold antenna, and the grand conductor layer of the circuit board is stabilized, and fluctuation of the resonance frequency of a surface mount mold antenna can be prevented.
[0024]

[Embodiment of the Invention] Below, the example of an operation gestalt concerning this invention is explained based on a drawing. The example of the 1st operation gestalt of the wireless radios applied to this invention using drawing 1 thru/or drawing 3 is shown.

[0025] In drawing 1 and drawing 2 , wireless radios are equipped with the surface mount mold antenna 10 and the rectangular circuit board 11, and are constituted. The surface mount mold antenna 10 consists of the electric supply components 13 and passive elements 14 which were formed in the front face of the base 12 of a dielectric, and this base 12. Moreover, the RF circuit which transmits and receives the signal of radio frequency and which is not illustrated is formed in the circuit board 11.

[0026] The electric supply component 13 of the surface mount mold antenna 10 consists of an electric supply radiation electrode 16 formed in the front principal plane of a base 12, an electric supply electrode 17 formed in the side face of a base 12, and a short stub 18. Direct continuation of the tip of the strip electric supply electrode 17 which turned the center of abbreviation of side-face 12a of a base 12 to the front principal plane side from the flesh-side principal plane side, and was elongated is carried out to the electric supply radiation electrode 16.

[0027] Moreover, all over the field of the electric supply radiation electrode 16, the slit 19 deeply cut from the electric supply electrode 17 side is formed, the effective track length of the electric supply radiation electrode 16 is set up, and the electric supply component 13 is equipped with electric merit lambda / 4 rootepsilon which resonates on the frequency f1 of a fundamental wave, for example, the frequency of 900MHz, and electric merit 3lambda/4 rootepsilon which resonates on the frequency f2 of the 2nd higher harmonic, for example, the frequency of 1800MHz. However, lambda is the wavelength of the frequency f1 of a fundamental wave, and epsilon is the effective dielectric constant of a base 12.

[0028] The short stub 18 is connected between the electric supply electrode 17 and the earth electrode which was formed in the flesh-side principal plane of a base 12 and which is not illustrated. While the input impedance of the electric supply component 13 is adjusted by 50 ohms by adjusting the value of the inductance component of this short stub 18, the resonance characteristic which the electric supply component 13 mentioned above is adjusted. The inductance value of the short stub 18 is changeable by trimming the short stub 18. Moreover, it may replace with the short stub 18 and a chip inductance may be

connected between the electric supply electrode 17, an earth electrode, or the grand conductor side of the circuit board 11.
[0029] The passive element 14 of the surface mount mold antenna 10 consists of a non-supplied electric power radiation electrode 20 which approached the electric supply radiation electrode 16 of the electric supply component 13, and was formed in the front principal plane of a base 12, and a grand electrode 21 formed in the same side-face 12a of the base 12 with which the electric supply electrode 17 is formed. The grand electrode 21 is brought near by the electric supply electrode 17, and is arranged in the center of abbreviation of base side-face 12a. Moreover, the non-supplied electric power radiation electrode 20 is connected to the earth electrode of a flesh-side principal plane through the grand electrode 21. This non-supplied electric power radiation electrode 20 is set as the effective track length which resonates on the frequency f3 belonging to the same cycle band as the resonance frequency f2 of the 2nd higher harmonic of the electric supply component 13.
[0030] On the other hand, in drawing 2 , the boundary length of the edge side, i.e., the sum of the die length of two shorter sides 11a and 11b and the die length of two long sides 11c and 11d, is longer than the half (lambda/2) of the wavelength of the frequency f1 of the fundamental wave of the electric supply component 13, and the circuit board 11 is constituted. Moreover, the input terminal 15 of a RF circuit is formed in the circuit board 11, and the electric supply terminal of the electric supply electrode 17 which turned to the flesh-side principal plane of a base 12, and was formed in it is connected to it. And except for the surroundings of an input terminal 15, the grand conductor side which consists of copper foil etc. and which is not illustrated is formed in the part of the circuit board 11 which installed the antenna 10 at least.
[0031] The surface mount mold antenna 10 constituted like **** is brought close and installed in shorter side 11a while it brings near the parts of the electric supply electrode 17 and the grand electrode 21 by the center section along with shorter side 11a of the circuit board 11. That is, it is arranged so that the distance S1 and S2 from the parts of the electric supply electrode 17 of the surface mount mold antenna 10 and the grand electrode 21 to the long sides 11c and 11d of the circuit board 11 may become equal.
[0032] Side-face 12a of the base 12 with which the surface mount mold antenna 10 formed the electric supply electrode 17 and the grand electrode 21 at this time is turned to shorter side 11a of the circuit board, and the open end side of the electric supply radiation electrode

16 and the non-supplied electric power radiation electrode 20, if it puts in another way, base side-face 12b of the electric supply electrode 17 and the grand electrode 21, and the opposite side is turned to other shorter side 11b of the circuit board 11. By this arrangement, the distance to the long sides 11c and 11d of the circuit board 11 seen from the parts of the electric supply electrode 17 and the grand electrode 21 serves as bilateral symmetry mostly. In addition, the surface mount mold antenna 10 makes in agreement with shorter side 11a of the circuit board 11 side-face 12a in which the electric supply electrode 17 and the grand electrode 21 were formed, or like drawing 1 , it separates from shorter side 11a a little, and it is installed.

[0033] In this configuration, if exciting power is supplied to the electric supply radiation electrode 16 through the electric supply electrode 17 of the electric supply component 13 from the input terminal 15 of the circuit board 11, the electric supply component 13 of the surface mount mold antenna 10 will resonate on the frequency f1 of a fundamental wave, and the frequency f2 of the 2nd higher harmonic. By the ability coming [ simultaneously ], the non-supplied electric power radiation electrode 20 carries out electric-field association with the electric supply radiation electrode 16, a passive element 14 is excited while the grand electrode 21 carries out field association with the electric supply electrode 17, and the resonance frequency f3 double-resonates with the frequency f2 of the 2nd higher harmonic of the electric supply component 13.

[0034] In the frequency band where the frequency f2 of the 2nd higher harmonic of the electric supply component 13 belongs here, maintaining the good return loss property in the resonance frequency f1 of the fundamental wave of the electric supply component 13 by double resonance of the electric supply component 13 and a passive element 14 as shown in drawing 3 , the return loss property of a broadband with the depth of required resonance is securable with the resonance frequency f2 of the 2nd higher harmonic of the electric supply component 13, and the resonance frequency f3 of a passive element 14.

[0035] In order to supply the radiant energy supplied to the electric supply radiation electrode 16 and the non-supplied electric power radiation electrode 20 at the time of above-mentioned actuation, the amount of currents which flows to the electric supply electrode 17 and the grand electrode 21 among the surface mount mold antennas 10 increases most. That is, a current concentrates [ the parts of the electric supply electrode 17 and the grand electrode 21 ] most among antennas. Moreover, to the circuit board 11, the substrate currents 23,

24, 25, and 26 flow with excitation of the surface mount mold antenna 10 along with the edge sides 11a, 11b, 11c, and 11d of the circuit board 11 from the parts of the electric supply electrode 17 and the grand electrode 21.

[0036] Among this, the substrate currents 23 and 24 which flow shorter side 11a of the circuit board 11 serve as opposition, and the substrate currents 25 and 26 which flow the long sides 11c and 11d of the circuit board 11 serve as an inphase. Therefore, in shorter side 11a of the circuit board 11, the electromagnetic field generated according to the substrate currents 23 and 24 are offset, and the electromagnetic field generated according to the substrate currents 23 and 24 become weak near the surface mount mold antenna 10. Moreover, the electromagnetic field by the substrate currents 25 and 26 which separate a few from the surface mount mold antenna 10, and flow the long sides 11c and 11d of the circuit board 11 act effectively as a part of electric wave emitted from wireless radios.

[0037] The example of the 2nd operation gestalt of the wireless radios applied to this invention using drawing 4 and drawing 5 is explained. In addition, the same sign is given to the same component as the example of the 1st operation gestalt, and duplication explanation of the intersection is omitted. This example of an operation gestalt has the description in the point excited by the indirect electric supply whose electric supply component of a surface mount mold antenna minded capacity.

[0038] In drawing 4 and drawing 5 , the surface mount mold antenna 30 is brought near and installed in the center section of shorter side 31a of the circuit board 31 like the above-mentioned example of an operation gestalt. This antenna 30 is carrying out a configuration which is different in the surface mount mold antenna 10 of drawing 1 , the earth side of the electric supply component 32 and a passive element 33 is arranged towards shorter side 31a of the circuit board 31, and the electric supply side of the electric supply component 32 is arranged towards another [ which the circuit board 31 does not illustrate ] shorter side.

[0039] The configuration of the surface mount mold antenna 30 is explained concretely. The electric supply radiation electrode 34 of the electric supply component 32 and the non-supplied electric power radiation electrode 35 of a passive element 33 are approached and formed in the front principal plane of the base 12 of the surface mount mold antenna 30. The strip grand electrodes 36 and 37 which approach and elongate the center section up and down are formed in side-face 12a of a

base 12. The electric supply radiation electrode 34 and the non-supplied electric power radiation electrode 35 are connected to the earth electrode of the flesh-side principal plane of a base 12 by these grand electrodes 36 and 37, respectively.
[0040] Moreover, the electric supply side of the electric supply component 32 is formed in side-face 12b which faced side-face 12a of a base 12. That is, the capacity loading electrodes 38 and 39 connected to the electric supply radiation electrode 34 and the non-supplied electric power radiation electrode 35, respectively are formed in side-face 12b of a base 12. And the electric supply electrode 40 which carries out capacity coupling to this capacity loading electrode 38 counters the capacity loading electrode 38 of the electric supply component 32, and it is formed, and the grand electrode 41 is countered and formed in the capacity loading electrode 39 of a passive element 33. The grand electrode 41 is connected to the earth electrode prepared in the flesh-side principal plane of a base 12, and open end capacity is formed between the capacity loading electrode 39 and the grand electrode 41.
[0041] The electric supply electrode 40 of the electric supply component 32 is connected to the input terminal 15 which separated from shorter side 31a of the circuit board 31, and was prepared all over the field of the circuit board 31. The grand conductor layer which is not illustrated except for the surroundings of an input terminal 15 is formed in the substrate side in which the input terminal 15 of the circuit board 31 was formed, and an input terminal 15 is connected to the RF circuit formed in the substrate side on a background through the through hole.
[0042] Excitation of the electric supply component 32 of supply of the signal power from a RF circuit resonates the electric supply component 32 on a frequency f1. Since the electric supply radiation electrode 34 of the electric supply component 32 and the non-supplied electric power radiation electrode 35 of a passive element 33 carry out electric-field association and the grand electrode 36 of the electric supply component 32 and the grand electrode 37 of a passive element 33 carry out field association at this time, a passive element 33 is excited by resonance frequency f1 on the approximate frequency f4 in the frequency band where the resonance frequency f1 of the electric supply component 32 belongs. As shown in drawing 6 , the resonance frequency f4 of a passive element 33 is adjusted by setting up suitably the open end capacity value between the capacity loading electrode 39 and the grand electrode 41 so that it may double-resonate with the resonance frequency f1 of the electric supply component 32.
[0043] Although the example of an operation gestalt mentioned above

explained installing the surface mount mold antennas 10 and 30 in the center section of the shorter sides 11a and 31a along with the edge of the shorter sides 11a and 31a of the circuit boards 11 and 31 As shown in drawing 7 , so that the distance S5 and S6 from the parts of the electric supply electrode 17 of the surface mount mold antenna 10 and the grand electrode 21 to both the shorter sides 44c and 44d of the circuit board 44 may become almost equal The surface mount mold antenna 10 may be installed in the abbreviation center section of the long side 44a along with long side 44a of the circuit board 44. Also in this case, the electric supply electrode 17 and the grand electrode 21 which a current concentrates most and flow among the surface mount mold antennas 10 are installed towards long side 44a.

[0044] If the surface mount mold antenna 10 is excited, along with long side 44a of the circuit board 44, the substrate currents 45 and 46 of opposition will flow to right and left of the surface mount mold antenna 10, and the substrate currents 47 and 48 of an inphase will flow along with the shorter sides 44c and 44d of the circuit board 44. In this actuation, since the distance in which the substrate currents 45 and 46 of opposition flow becomes long compared with drawing 1 and the example of the 1st operation gestalt of drawing 2 , the electromagnetic field generated according to the substrate currents 45 and 46 are offset to the point distant from drawing 1 and the example of the 1st operation gestalt of drawing 2 . Also in this case, the boundary length of the circuit board 44 is constituted by lambda/2 or more die length, and the circuit board 44 operates as some surface mount mold antennas 10 like ****.

[0045] An experimental result is explained. The surface mount mold antenna used for a comparison is the double resonant antenna 50 of the single band shown in the single resonant antenna 1 and drawing 8 of a configuration of being shown in drawing 12 . These antennas 1 and 50 are constituted by the same volume (width of face of 12mm, die length of 18mm, height of 6mm) using the base of the same specific inductive capacity. The dimension of the circuit board 51 which mounts antennas 1 and 50 is 1mm in width of face of 40mm, die length of 110mm, and thickness.

[0046] If the configuration of the surface mount mold antenna 50 shown in drawing 8 is explained simple, the electric supply radiation electrode 53 and the non-supplied electric power radiation electrode 54 are formed in the front principal plane of a base 52, and the earth electrode 55 is formed in the flesh-side principal plane. The electric supply electrode 56 is formed in the center of abbreviation of a base

side face, direct continuation of the end is carried out to the electric supply radiation electrode 53, and the other end turns to a flesh-side principal plane, and serves as the electric supply terminal 57. Moreover, it connects with an earth electrode 55 through the grand electrode 58 formed in the base side face, and the end side of the non-supplied electric power radiation electrode 54 is connected to the capacity loading electrode 60 which countered the other end with the grand electrode 59 formed in other base side faces, and was formed.

[0047] A setup of measurement is explained using drawing 9 . The circuit board 61 which mounted the single resonant antenna 1, and the circuit board 62 which mounted the double resonant antenna 50 were prepared. The phantom 63 was approached in order of measurement, and these circuit boards 61 and 62 have been arranged. The substrate side of the circuit boards 61 and 62 was stood at right angles to the ground, and spacing of the substrate side on the background of a part and phantom 63 which installed antennas 1 and 50 was set as 5mm. Moreover, to the ground, the circuit boards 61 and 62 were leaned 45 degrees, and were installed. In addition, 64 is support (false hand) which holds the circuit boards 61 and 62 in a measurement location.

[0048] Moreover, the installation location of the antennas 1 and 50 to the circuit boards 61 and 62 is explained using drawing 10 . Antennas 1 and 50 were turned to the shorter sides 61a and 62a of the circuit boards 61 and 62, and have arranged electric supply electrode 5 and 56 side, and the electric supply locations A1 and A2 and A3 which are three from which the distance from the left-hand side substrate edges 61b and 62b differs along with the shorter sides 61a and 62a of the circuit boards 61 and 62 were set up in consideration of the width method of a base 52.

[0049] The electric supply location A1 is a location (A1=6mm) of the electric supply electrode 5 when bringing near the single resonant antenna 1 by substrate edge 61b on the left-hand side of the circuit board 61. Electric supply location A3 is the center (A3=20mm) of the shorter sides 61a and 62a of the circuit boards 61 and 62, and this electric supply location A3 is a location which arranges the electric supply electrode 5 of the single resonant antenna 1, and the electric supply electrode 56 of the double resonant antenna 50. Moreover, the electric supply location A2 is a middle location (A2=13mm) of A1 and A3.

[0050] The frequency used for measurement is 1480MHz. The measurement result was as in the next table 1.

[0051]

[Table 1]

| アンテナの種類 | 給電位置 | ファントム近傍利得（dBd） | | 帯域幅(MHz) VSWR<3 |
|---|---|---|---|---|
| | | 水平偏波 | 垂直偏波 | |
| 単共振 | A1 | -8.1 | -16.8 | 66.2 |
| | A2 | -7.6 | -15.3 | 48.9 |
| | A3 | -7.1 | -12.7 | 38.6 |
| 複共振 | A3 | -7.1 | -12.0 | 84.0 |

[0052] The single resonant antenna 1 is followed on moving the electric supply electrode 5 in the direction of A3 from the electric supply location A1, and its gain in about 63 phantom improves so that clearly from this table 1. However, the frequency bandwidth from which VSWR (voltage standing wave ratio) becomes less than three becomes narrow conversely. On the other hand, although gain will become equivalent as compared with the single resonant antenna 1 if the electric supply electrode 56 of the double resonant antenna 50 is arranged to electric supply location A3, frequency bandwidth spreads more than twice. This frequency bandwidth is larger than frequency bandwidth when the electric supply electrode 5 of the single resonant antenna 1 has been arranged in the electric supply location A1.

[0053]

[Effect of the Invention] Since a substrate current arranges the part which a current concentrates most among the surface mount mold antennas at the time of a communication link in the location where the die length of the edge side which flows to the opposite sense becomes almost equal according to the wireless radios of claim 1, the electromagnetic field near [ by the substrate current which flows to the circuit board ] the surface mount mold antenna are offset, or it can decrease, and it is hard to be influenced of a user, it can be carried out, and an antenna property can be made stability.

[0054] Moreover, although the frequency bandwidth of a surface mount mold antenna becomes narrow by having installed the surface mount mold antenna in the center of edge side abbreviation of the circuit board, since the electric supply component and passive element of a surface mount mold antenna are double-resonated, sufficient frequency bandwidth is securable.

[0055] According to the wireless radios of claim 2, since the electric supply electrode and grand electrode of a surface mount mold antenna are arranged in the abbreviation center section of any one edge side of the circuit board, the substrate current which flows the nearness of a

surface mount mold antenna is offset. Therefore, degradation of the antenna property by the electromagnetic field near the antenna being confused in response to the effect of a user can be eased. Moreover, since a surface mount mold antenna is the configuration of double-resonating an electric supply component and a passive element, it can extend the bandwidth of the frequency band used with a surface mount mold antenna.

[0056] Even when exciting a surface mount mold antenna by capacity electric supply according to the wireless radios of claim 3 Since the grand electrode of an electric supply component and a passive element with which a current becomes the strongest among surface mount mold antennas is arranged in the abbreviation center section of one edge side of the circuit board Degradation of the antenna property by the electromagnetic field near the antenna being confused in response to the effect of a user can be eased, and fixed distance detached building ****** can be used from the surface mount mold antenna in the circuit board as some surface mount mold antennas to coincidence.

[0057] According to the wireless radios of claim 4, since the resonance frequency of the 2nd higher harmonic of an electric supply component and the resonance frequency of a passive element are double-resonated, in the frequency characteristics of return loss, the gap of adjustment between the frequency of the fundamental wave of an electric supply component and the frequency of the 2nd higher harmonic can be eased.

[0058] Since the boundary length which met the edge side of the circuit board was made into lambda/2 or more die length according to the wireless radios of claim 5, the circuit board can be operated as some surface mount mold antennas.

[0059] According to the wireless radios of claim 6, since a surface mount mold antenna is installed in the grand conductor side of the circuit board, actuation of a surface mount mold antenna can be stabilized.

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the important section perspective view showing the example of the 1st operation gestalt of the surface mount mold antenna mounting part in the wireless radios concerning this invention.
[Drawing 2] It is a top view explaining the surface mount mold antenna mounting part in the wireless radios of drawing 1 .
[Drawing 3] It is the frequency-characteristics Fig. of the return loss in the surface mount mold antenna of the wireless radios of drawing 1 .
[Drawing 4] It is the important section perspective view showing the example of the 2nd operation gestalt of the surface mount mold antenna mounting part in the wireless radios concerning this invention.
[Drawing 5] It is the important section tooth-back perspective view of the surface mount mold antenna mounting part in drawing 4 .
[Drawing 6] It is the frequency-characteristics Fig. of the return loss in the surface mount mold antenna of the wireless radios of drawing 4 .
[Drawing 7] It is a top view explaining the example of the 3rd operation gestalt of the surface mount mold antenna mounting part in the wireless radios concerning this invention.
[Drawing 8] The surface mount mold antenna used for measurement of the antenna property concerning the wireless radios of this invention is shown, (A) is a surface perspective view and (B) is a tooth-back perspective view.
[Drawing 9] It is the explanatory view showing the Measuring condition of the antenna property concerning the wireless radios of this invention.
[Drawing 10] It is the explanatory view showing the mounting position of the surface mount mold antenna for measuring the antenna property concerning the wireless radios of this invention.
[Drawing 11] It is the top view showing the mounting gestalt of the surface mount mold antenna in the conventional wireless radios.
[Drawing 12] It is the perspective view showing the surface mount mold antenna of the conventional single resonance.
[Description of Notations]
10, 30, 50 Surface mount mold antenna
11, 31, 44, 61, 62 Circuit board
11a, 11b, 31a, 44c, 44d, 61a, 62a Shorter side

11c, 11d, 44a, 44b, 61b, 62b Long side
13 32 Electric supply component
14 33 Passive element
15 Input Terminal
16, 34, 53 Electric supply radiation electrode
17, 40, 56 Electric supply electrode
20, 35, 54 Non-supplied electric power radiation electrode
21, 36, 37, 41, 58, 59 Grand electrode
23, 24, 25, 26, 45, 46, 47, 48 Substrate current

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[Translation done.]

* NOTICES *



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DRAWINGS

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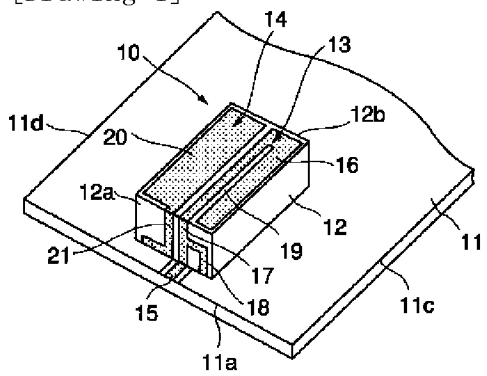
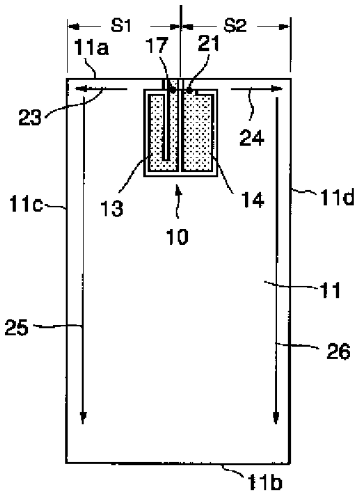
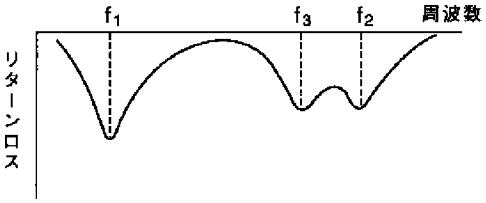
[Drawing 1]



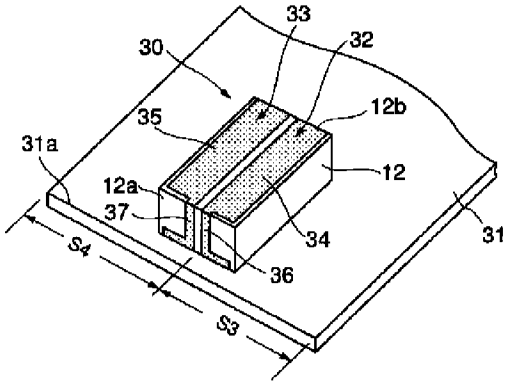

[Drawing 2]



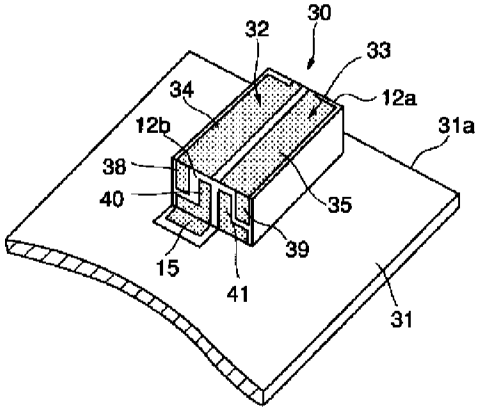

[Drawing 3]



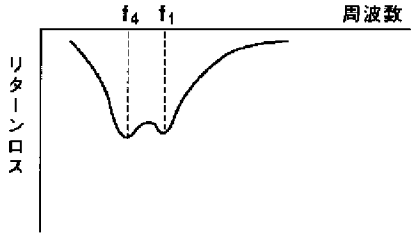

[Drawing 4]



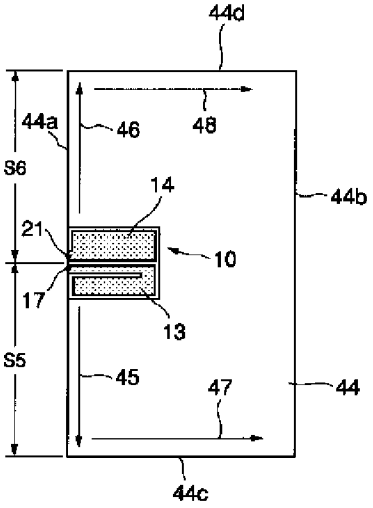

[Drawing 5]



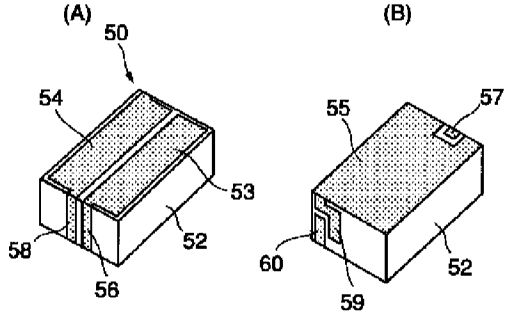
[Drawing 6]



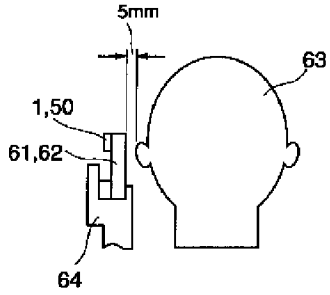

[Drawing 7]



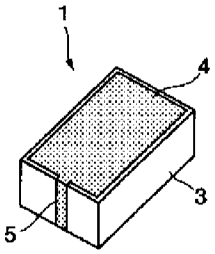

[Drawing 8]



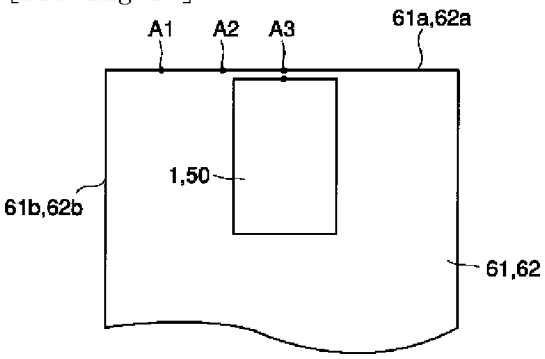

[Drawing 9]



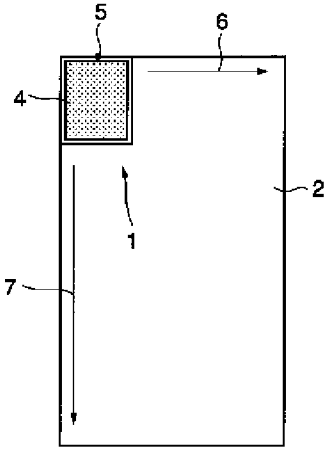
[Drawing 12]




[Drawing 10]




[Drawing 11]

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[Translation done.]

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（P2003－78321A）
(43)公開日　平成15年３月14日(2003.3.14)

| (51)Int.Cl.[7] | 識別記号 | ＦＩ | | テーマコード（参考） |
|---|---|---|---|---|
| Ｈ０１Ｑ 1/38 | | Ｈ０１Ｑ 1/38 | | ５Ｊ０４５ |
| 1/24 | | 1/24 | Ｚ | ５Ｊ０４６ |
| 1/52 | | 1/52 | | ５Ｊ０４７ |
| 5/01 | | 5/01 | | |
| 9/40 | | 9/40 | | |

審査請求　未請求　請求項の数６　ＯＬ　（全　９　頁）　最終頁に続く

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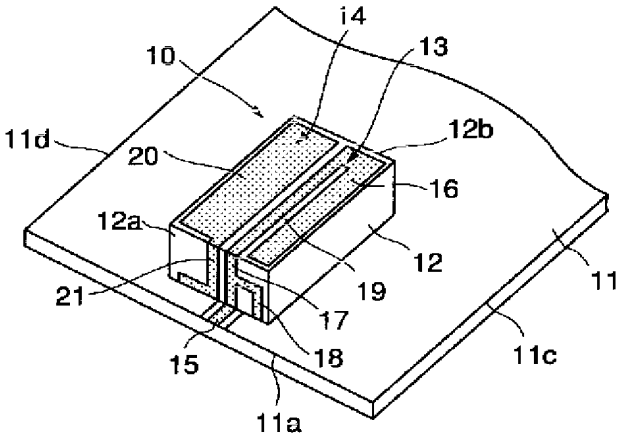
(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者　尾仲　健吾
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(72)発明者　石原　尚
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(74)代理人　100093894
弁理士　五十嵐　清

最終頁に続く

(54)【発明の名称】　無線通信機

(57)【要約】
【課題】　表面実装型アンテナの動作を安定に保持しつつ十分な周波数帯域幅を確保する。
【解決手段】　表面実装型アンテナ１０は、誘電体の基体の表面に形成した給電素子１３と無給電素子１４から構成される。給電素子１３は、給電放射電極１６と給電電極１７を含み、また、無給電素子１４は、無給電放射電極２０とグランド電極２１を含んで構成され、給電素子１３と無給電素子１４は複共振する。表面実装型アンテナ１０は、給電電極１７及びグランド電極２１が回路基板１１の端辺１１ａの略中央部に位置するように実装される。



【特許請求の範囲】
【請求項１】　給電素子と少なくとも１つの無給電素子とを有する表面実装型アンテナと、該アンテナを設置する回路基板とを備える無線通信機に於いて、
前記アンテナの前記給電素子と前記無給電素子を複共振させると共に、前記給電素子及び前記無給電素子に流れる電流が最も集中する前記アンテナの電流集中部位を、前記回路基板に於ける基板電流が前記電流集中部位を起点として反対向きに流れる端辺の長さがほぼ等しくなる位置に配置することを特徴とする無線通信機。
【請求項２】　誘電体の基体の表面に、給電放射電極及び該給電放射電極に接続された給電電極を含む給電素子と、無給電放射電極及び該無給電放射電極に接続されたグランド電極を含む少なくとも１つの無給電素子とを備える表面実装型アンテナと、該アンテナを設置する方形の回路基板とを備える無線通信機に於いて、
前記給電素子と前記無給電素子を複共振させると共に、前記アンテナの前記給電電極及び前記グランド電極を、前記回路基板の何れか１つの端辺の略中央部に配置することを特徴とする無線通信機。
【請求項３】　誘電体の基体の表面に、給電放射電極及び該給電放射電極に接続されたグランド電極並びに前記給電放射電極と容量結合する給電電極を含む給電素子と、無給電放射電極及び該無給電放射電極に接続されたグランド電極を含む少なくとも１つの無給電素子とを有する表面実装型アンテナと、該アンテナを設置する方形の回路基板とを備える無線通信機に於いて、
前記給電素子と前記無給電素子を複共振させると共に、前記アンテナの前記両グランド電極を、前記回路基板の何れか１つの端辺の略中央部に配置することを特徴とする無線通信機。
【請求項４】　前記給電素子を基本波の周波数と第２高調波の周波数で共振すると共に、前記無給電素子の共振周波数を前記給電素子の第２高調波の共振周波数と複共振させることを特徴とする請求項１又は請求項２又は請求項３に記載の無線通信機。
【請求項５】　前記回路基板の端辺に沿った周囲長がλ／２（但し、λは使用周波数の基本波の波長）以上の長さであることを特徴とする請求項１乃至請求項４の何れか１つに記載の無線通信機。
【請求項６】　前記回路基板にグランド導体面を設けると共に該グランド導体面に前記アンテナを設置することを特徴とする請求項１乃至請求項５の何れか１つに記載の無線通信機。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、無線通信機、特に、回路基板に表面実装型アンテナを実装した無線通信機に関するものである。
【０００２】
【背景技術】近年、携帯電話機等の移動体通信機の小型化が進んでいるが、アンテナ部分が移動体通信機の外部に突出していることが多く取扱いが不便となることがある。このような不便を解消するため、アンテナを完全に筐体内部に収容した移動体通信機が市販されている。この移動体通信機では、例えば、図１１に示すように、表面実装型アンテナ１は回路基板２の上に実装されている。そして、回路基板２には無線周波の送受信回路（ＲＦ回路）やベースバンドの信号処理回路が形成されている。
【０００３】上述のような表面実装型アンテナ１は、図１２に示すように、誘電体の基体３の表主面に放射電極４が形成され、裏主面には図示しない接地電極が形成されている。放射電極４には基体３の側面を利用して給電電極５が接続されており、この給電電極５を介してＲＦ回路から放射電極４に給電される。表面実装型アンテナ１を回路基板２に実装すると、表面実装型アンテナ１の電界が回路基板２の接地電位と結合し易くなるため、表面実装型アンテナ１のＱが大きくなって周波数帯域幅が狭くなる。このことから、表面実装型アンテナ１は、回路基板２の角部分に寄せて設置される。
【０００４】表面実装型アンテナ１が励振されると、回路基板２には、その端辺に沿って基板電流６，７が流れ、回路基板２が表面実装型アンテナ１の一部の如く作用し、表面実装型アンテナ１の見かけ上の放射抵抗を大きくしてアンテナの利得を高くすると共に、表面実装型アンテナ１の周波数帯域に於いて十分な帯域幅が得られる。
【０００５】
【発明が解決しようとする課題】しかしながら、回路基板２に基板電流６，７が流れることにより、表面実装型アンテナ１を設置した部位の回路基板２の裏側にも基板電流６，７による電磁界が発生する。このため、使用者による無線通信機の取扱方によっては、使用者の影響を受け、表面実装型アンテナ１近傍の電磁界が乱れ、表面実装型アンテナ１自身の動作に影響を与える虞があった。
【０００６】本発明は上述の課題を解決するために成されたものであり、その目的は、表面実装型アンテナに於ける十分な周波数帯域幅を確保し且つアンテナの動作を安定にした無線通信機を提供することにある。
【０００７】
【課題を解決するための手段】上述の目的を達成するために、本発明は次に示す構成をもって課題を解決する手段としている。即ち、第１の発明の無線通信機は、給電素子と少なくとも１つの無給電素子とを有する表面実装型アンテナと、このアンテナを設置する回路基板とを備えている。特徴として、表面実装型アンテナの給電素子と無給電素子を複共振させると共に、給電素子及び無給電素子に流れる電流が最も集中するアンテナの部位を、

回路基板に於ける基板電流が電流集中部位を起点として反対向きに流れる端辺の長さがほぼ等しくなる位置に配置する構成をもって課題を解決する手段としている。

【０００８】上述の発明に於いて、表面実装型アンテナが励振されると、表面実装型アンテナを設置した回路基板には、電流集中部位を起点として基板電流が流れる。表面実装型アンテナは、電流が最も集中する部位が、回路基板に流れる基板電流の内、反対向きに流れる端辺の長さがほぼ等しくなる位置に配置されるので、表面実装型アンテナが設置された端辺では、表面実装型アンテナの内で電流が最も強くなる部分を起点として左右に逆向きの基板電流が流れると共に、逆向きの基板電流が流れている距離、換言すれば、回路基板の１つの端辺に沿って基板電流が逆向きに流れる端辺の長さがほぼ等しくなる。

【０００９】このため、表面実装型アンテナが設置された回路基板の端辺に於いては、基板電流により発生する電磁界は相殺され、或いは減衰される。換言すれば、アンテナ近傍では、基板電流による電磁界が存在しないか、或いは存在しても極めて弱い電磁界となる。従って、アンテナ近傍では、使用者の影響によって生じる電磁界の乱れを考慮する必要がなく、表面実装型アンテナ自身の特性が安定化する。この場合に於いても、表面実装型アンテナから離れた回路基板の端辺に於いて、同じ向きの基板電流が流れる端辺は、アンテナの一部として動作する。

【００１０】また、表面実装型アンテナを回路基板の角部分から、例えば、回路基板の端辺の略中央部に寄せて設置すると、表面実装型アンテナの周波数帯域幅が狭くなるが、同じ周波数帯域に於いて、表面実装型アンテナを構成する給電素子と無給電素子とを複共振させて周波数帯域幅を広げるので、十分な広さの帯域幅を確保することができる。

【００１１】第２の発明の無線通信機は、誘電体の基体の表面に、給電放射電極及びこの給電放射電極に接続された給電電極を含む給電素子と、無給電放射電極及びこの無給電放射電極に接続されたグランド電極を含む少なくとも１つの無給電素子とを備える表面実装型アンテナと、このアンテナを設置する方形の回路基板とを備えている。特徴として、給電素子と無給電素子を複共振させると共に、表面実装型アンテナの給電電極及びグランド電極を、回路基板の何れか１つの端辺の略中央部に配置することを特徴として構成されている。

【００１２】この発明によれば、表面実装型アンテナの内で給電電極及びグランド電極の部分が最も電流量が多くなるが、表面実装型アンテナは、給電電極及びグランド電極を、回路基板の一辺の略中央部に寄せ、また、回路基板の基板端に向けて配置するように設置されるので、回路基板に流れる基板電流の内、表面実装型アンテナの間近を流れる基板電流により発生する電磁界は相殺される。従って、アンテナの近傍では、外的要因に起因する基板電流による電磁界の乱れは生じない。この場合にも、回路基板の端辺を同じ向きに流れる基板電流により発生する電磁界は、表面実装型アンテナから放射される電磁界の一部となる。

【００１３】また、表面実装型アンテナは、単バンドのアンテナとして構成することができ、給電素子は１つの周波数帯域で共振するように構成される。この場合、無給電素子の共振周波数を給電素子の共振周波数と複共振させることにより、広帯域の表面実装型アンテナとすることができる。

【００１４】更に、表面実装型アンテナは、デューアルバンドのアンテナとして構成することもできる。このときには、給電素子は、基本波の周波数と高次高調波の周波数で共振するように構成される。例えば、基本波の周波数と高次高調波の周波数の内、何れか一方の共振周波数に於いて良好なリターンロス特性が得られない場合には、その共振周波数と無給電素子の共振周波数を複共振させてリターンロスを改善する。勿論、給電素子のリターンロスが良好な共振周波数と他の無給電素子の共振周波数を複共振させることにより、その共振周波数が属する周波数帯域の帯域幅を広げることも可能である。

【００１５】第３の発明の無線通信機は、誘電体の基体の表面に、給電放射電極及びこの給電放射電極に接続されたグランド電極並びに給電放射電極と容量結合する給電電極を含む給電素子と、無給電放射電極及びこの無給電放射電極に接続されたグランド電極を含む少なくとも１つの無給電素子とを有する表面実装型アンテナと、このアンテナを設置する方形の回路基板とを備えている。特徴として、給電素子と無給電素子を複共振させると共に、表面実装型アンテナの両グランド電極を、回路基板の何れか１つの端辺の略中央部に配置することを特徴として構成されている。

【００１６】この発明によれば、給電素子は、給電放射電極の一端を接地した容量給電素子として構成されているので、表面実装型アンテナに於いて電流が集中する給電素子のグランド電極が、同様に電流が集中する無給電素子のグランド電極と共に回路基板の端辺の略中央部に寄せられ且つ回路基板の基板端に近付けて配置される。このアンテナに於いても、給電素子のグランド電極と無給電素子のグランド電極の部分から左右に逆向きの基板電流が流れるが、表面実装型アンテナの間近では基板電流が互いに打ち消されるので、アンテナ近傍に於いて、基板電流による電磁界の乱れは生じない。

【００１７】上述の発明に於ける表面実装型アンテナも、第２の発明と同様に、表面実装型アンテナは、単バンドのアンテナとして、また、デューアルバンドのアンテナとして構成することができ、周波数帯域幅の狭い周波数帯域では、給電素子と無給電素子を複共振させることにより、周波数帯域幅を２倍程度に広げることができ

る。

【００１８】第４の発明の無線通信機は、上述の何れかの発明に於いて、給電素子を基本波の周波数と第２高調波の周波数で共振すると共に、無給電素子の共振周波数を給電素子の第２高調波の共振周波数と複共振させることを特徴として構成されている。

【００１９】この構成の採用により、基本波の周波数に於いてリターンロスの最適な整合が得られるが、第２高調波の周波数ではリターンロスが整合不良となるとき、無給電素子の共振周波数を給電素子の第２高調波の周波数と複共振させることにより、第２高調波の周波数が属する周波数帯域に於いて第２高調波の周波数に於けるリターンロスの整合不良が改善される。これにより、表面実装型アンテナは、２つの周波数帯域を持った、所謂、デューアルバンドのアンテナとなる。

【００２０】第５の発明の無線通信機は、上述の何れかの発明に於いて、回路基板の端辺に沿った周囲長がλ／２（但し、λは使用周波数の基本波の波長）以上の長さであることを特徴として構成されている。

【００２１】この構成により、回路基板に流れる同じ向きの基板電流に基づいて発生する電磁界は、表面実装型アンテナから放射する電磁界の一部となり、表面実装型アンテナから放射される電磁波の放射に寄与する。

【００２２】第６の発明の無線通信機は、上述の何れかの発明に於いて、回路基板にグランド導体面を設けると共にこのグランド導体面に表面実装型アンテナを設置することを特徴として構成されている。

【００２３】この構成の採用により、表面実装型アンテナを構成する給電放射電極及び無給電放射電極と回路基板のグランド導体層との間の浮遊容量値が安定し、表面実装型アンテナの共振周波数の変動を防ぐことができる。

【００２４】

【発明の実施の形態】以下に、本発明に係る実施形態例を図面に基づいて説明する。図１乃至図３を用いて本発明に係る無線通信機の第１実施形態例を示す。

【００２５】図１及び図２に於いて、無線通信機は、表面実装型アンテナ１０と長方形の回路基板１１とを備えて構成される。表面実装型アンテナ１０は、誘電体の基体１２と、この基体１２の表面に形成された給電素子１３と無給電素子１４から構成されている。また、回路基板１１には、無線周波の信号を送受信する図示しない高周波回路が形成されている。

【００２６】表面実装型アンテナ１０の給電素子１３は、基体１２の表主面に形成された給電放射電極１６と、基体１２の側面に形成された給電電極１７及びショートスタブ１８から構成されている。給電放射電極１６には、基体１２の側面１２ａの略中央を裏主面側から表主面側に向けて伸張したストリップ状の給電電極１７の先端が直接接続されている。

【００２７】また、給電放射電極１６の面中には、給電電極１７側から切り込んだスリット１９が形成されて給電放射電極１６の実効線路長が設定されており、給電素子１３は、基本波の周波数ｆ１、例えば、９００ＭＨｚの周波数で共振する電気長λ／４√εと、第２高調波の周波数ｆ２、例えば、１８００ＭＨｚの周波数で共振する電気長３λ／４√εを備えている。但し、λは基本波の周波数ｆ１の波長、εは基体１２の実効誘電率である。

【００２８】ショートスタブ１８は、給電電極１７と基体１２の裏主面に形成された図示しない接地電極の間に接続されている。このショートスタブ１８のインダクタンス成分の値を調整することにより、給電素子１３の入力インピーダンスが５０Ωに整合されると共に、給電素子１３の上述した共振特性が調整される。ショートスタブ１８のインダクタンス値は、ショートスタブ１８をトリミングすることにより変えることができる。また、ショートスタブ１８に代えて給電電極１７と接地電極又は回路基板１１のグランド導体面の間にチップインダクタンスを接続しても良い。

【００２９】表面実装型アンテナ１０の無給電素子１４は、給電素子１３の給電放射電極１６に近接して基体１２の表主面に形成された無給電放射電極２０と、給電電極１７が設けられている基体１２の同じ側面１２ａに形成されたグランド電極２１から構成されている。グランド電極２１は、給電電極１７に寄せて基体側面１２ａの略中央に配置されている。また、無給電放射電極２０は、グランド電極２１を介して裏主面の接地電極に接続されている。この無給電放射電極２０は、給電素子１３の第２高調波の共振周波数ｆ２と同じ周波帯域に属する周波数ｆ３で共振する実効線路長に設定されている。

【００３０】一方、図２に於いて、回路基板１１は、その端辺の周囲長、即ち、２つの短辺１１ａ，１１ｂの長さと２つの長辺１１ｃ，１１ｄの長さの和が、給電素子１３の基本波の周波数ｆ１の波長の二分の一（λ／２）よりも長く構成されている。また、回路基板１１には、高周波回路の入力端子１５が形成されており、基体１２の裏主面に回り込んで形成された給電電極１７の給電端子が接続されている。そして、回路基板１１の少なくともアンテナ１０を設置した部分には、入力端子１５の周りを除き、銅箔等からなる図示しないグランド導体面が形成されている。

【００３１】上述の如く構成した表面実装型アンテナ１０は、給電電極１７及びグランド電極２１の部分を回路基板１１の短辺１１ａに沿って中央部に寄せると共に短辺１１ａに近付けて設置される。即ち、表面実装型アンテナ１０の給電電極１７及びグランド電極２１の部分から回路基板１１の長辺１１ｃ，１１ｄまでの距離Ｓ１，Ｓ２が等しくなるように配置される。

【００３２】このとき、表面実装型アンテナ１０は、給

電電極１７及びグランド電極２１を設けた基体１２の側面１２ａが回路基板の短辺１１ａに向けられ、給電放射電極１６及び無給電放射電極２０の開放端側、換言すれば、給電電極１７及びグランド電極２１と反対側の基体側面１２ｂが回路基板１１の他の短辺１１ｂに向けられている。この配置により、給電電極１７及びグランド電極２１の部分から見た回路基板１１の長辺１１ｃ、１１ｄまでの距離は、ほぼ左右対称となる。なお、表面実装型アンテナ１０は、給電電極１７及びグランド電極２１を形成した側面１２ａを、回路基板１１の短辺１１ａと一致させるか或いは図１のように短辺１１ａから若干離して設置される。

【００３３】この構成に於いて、回路基板１１の入力端子１５から給電素子１３の給電電極１７を介して給電放射電極１６に励振電力が供給されると、表面実装型アンテナ１０の給電素子１３は、基本波の周波数ｆ１及び第２高調波の周波数ｆ２で共振する。これと同時に、無給電素子１４は、グランド電極２１が給電電極１７と磁界結合すると共に無給電放射電極２０が給電放射電極１６と電界結合して励振され、その共振周波数ｆ３は給電素子１３の第２高調波の周波数ｆ２と複共振する。

【００３４】ここに、給電素子１３と無給電素子１４の複共振により、図３に示すように、給電素子１３の基本波の共振周波数ｆ１に於ける良好なリターンロス特性を維持したままで、給電素子１３の第２高調波の周波数ｆ２が属する周波数帯域に於いて、給電素子１３の第２高調波の共振周波数ｆ２と無給電素子１４の共振周波数ｆ３により、必要な共振の深さを持った広帯域のリターンロス特性を確保することができる。

【００３５】上述の動作のとき、給電放射電極１６及び無給電放射電極２０に供給する放射エネルギーを供給するため、表面実装型アンテナ１０の内で給電電極１７及びグランド電極２１に流れる電流量が最も多くなる。つまり、給電電極１７及びグランド電極２１の部分がアンテナの内で最も電流が集中する。また、表面実装型アンテナ１０の励振に伴って、回路基板１１には、給電電極１７及びグランド電極２１の部分から回路基板１１の端辺１１ａ，１１ｂ，１１ｃ，１１ｄに沿って基板電流２３，２４，２５，２６が流れる。

【００３６】この内、回路基板１１の短辺１１ａを流れる基板電流２３，２４は逆相となり、回路基板１１の長辺１１ｃ、１１ｄを流れる基板電流２５，２６は同相となる。従って、回路基板１１の短辺１１ａでは、基板電流２３，２４により発生する電磁界は相殺され、表面実装型アンテナ１０の近傍では、基板電流２３，２４により発生する電磁界が弱くなる。また、表面実装型アンテナ１０から少し離れて回路基板１１の長辺１１ｃ、１１ｄを流れる基板電流２５，２６による電磁界は、無線通信機から放射される電波の一部として有効に作用する。

【００３７】図４及び図５を用いて本発明に係る無線通信機の第２実施形態例を説明する。なお、第１実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。この実施形態例は、表面実装型アンテナの給電素子が容量を介した間接給電により励振される点に特徴がある。

【００３８】図４及び図５に於いて、表面実装型アンテナ３０は、上述の実施形態例と同様に、回路基板３１の短辺３１ａの中央部に寄せて設置される。このアンテナ３０は、図１の表面実装型アンテナ１０とは異なった構成をしており、給電素子３２及び無給電素子３３の接地側が回路基板３１の短辺３１ａに向けて配置され、給電素子３２の給電側は回路基板３１の図示しないもう一方の短辺に向けて配置されている。

【００３９】表面実装型アンテナ３０の構成を具体的に説明する。表面実装型アンテナ３０の基体１２の表主面には、給電素子３２の給電放射電極３４と無給電素子３３の無給電放射電極３５が近接して形成されている。基体１２の側面１２ａには、その中央部を、近接して上下に伸張するストリップ状のグランド電極３６，３７が形成されている。このグランド電極３６，３７により、給電放射電極３４と無給電放射電極３５は、夫々基体１２の裏主面の接地電極に接続されている。

【００４０】また、基体１２の側面１２ａと向かい合った側面１２ｂには、給電素子３２の給電側が形成されている。即ち、基体１２の側面１２ｂには、給電放射電極３４と無給電放射電極３５に夫々接続された容量装荷電極３８，３９が形成されている。そして、給電素子３２の容量装荷電極３８には、この容量装荷電極３８と容量結合する給電電極４０が対向して形成され、また、無給電素子３３の容量装荷電極３９には、グランド電極４１が対向して形成されている。グランド電極４１は基体１２の裏主面に設けた接地電極に接続されており、容量装荷電極３９とグランド電極４１の間には開放端容量が形成される。

【００４１】給電素子３２の給電電極４０は、回路基板３１の短辺３１ａから離れて回路基板３１の面中に設けた入力端子１５に接続されている。回路基板３１の入力端子１５を設けた基板面には、入力端子１５の周りを除き図示しないグランド導体層が形成されており、また、入力端子１５は、例えば、スルーホールを介して裏側の基板面に形成された高周波回路に接続される。

【００４２】高周波回路からの信号電力の供給により給電素子３２が励振されると、給電素子３２は、周波数ｆ１で共振する。このとき、給電素子３２の給電放射電極３４と無給電素子３３の無給電放射電極３５は電界結合し、また、給電素子３２のグランド電極３６と無給電素子３３のグランド電極３７が磁界結合するので、無給電素子３３は、給電素子３２の共振周波数ｆ１が属する周波数帯域に於いて共振周波数ｆ１に近似の周波数ｆ４で励振される。無給電素子３３の共振周波数ｆ４は、図６

に示すように、例えば、容量装荷電極３９とグランド電極４１の間の開放端容量値を適宜に設定することにより給電素子３２の共振周波数ｆ１と複共振するように整合される。

【００４３】上述した実施形態例では、表面実装型アンテナ１０，３０を回路基板１１，３１の短辺１１ａ，３１ａの端縁に沿ってその短辺１１ａ，３１ａの中央部に設置することを説明したが、図７に示すように、表面実装型アンテナ１０の給電電極１７及びグランド電極２１の部分から回路基板４４の両短辺４４ｃ、４４ｄまでの距離Ｓ５，Ｓ６がほぼ等しくなるように、表面実装型アンテナ１０を、回路基板４４の長辺４４ａに沿って、その長辺４４ａの略中央部に設置しても良い。この場合にも、表面実装型アンテナ１０の内で最も電流が集中して流れる給電電極１７とグランド電極２１は、長辺４４ａに向けて設置される。

【００４４】表面実装型アンテナ１０が励振されると、回路基板４４の長辺４４ａに沿って表面実装型アンテナ１０の左右に逆相の基板電流４５，４６が流れ、回路基板４４の短辺４４ｃ、４４ｄに沿って同相の基板電流４７，４８が流れる。この動作では、逆相の基板電流４５，４６が流れる距離が、図１及び図２の第１実施形態例に比べて長くなるので、基板電流４５，４６によって発生する電磁界は、図１及び図２の第１実施形態例よりも離れた地点まで相殺される。この場合にも、回路基板４４の周囲長はλ／２以上の長さに構成されており、回路基板４４は、上述同様に、表面実装型アンテナ１０の一部として動作する。

【００４５】実験結果について説明する。比較に用いる表面実装型アンテナは、図１２に示す構成の単共振アンテナ１と図８に示す単バンドの複共振アンテナ５０である。これらのアンテナ１，５０は、同じ比誘電率の基体を用いて同じ体積（幅１２ｍｍ、長さ１８ｍｍ、高さ６ｍｍ）に構成されている。アンテナ１，５０を実装する回路基板５１の寸法は、幅４０ｍｍ、長さ１１０ｍｍ、厚み１ｍｍである。

【００４６】図８に示した表面実装型アンテナ５０の構成を簡略に説明すると、基体５２の表主面には給電放射電極５３と無給電放射電極５４が形成され、裏主面に接地電極５５が形成されている。基体側面の略中央には給電電極５６が形成され、その一端が給電放射電極５３に直接接続され、他端は裏主面に回り込んで給電端子５７となっている。また、無給電放射電極５４の一端側は基体側面に形成されたグランド電極５８を介して接地電極５５に接続され、他端には他の基体側面に形成されたグランド電極５９と対向して形成された容量装荷電極６０に接続されている。

【００４７】図９を用いて計測の設定を説明する。単共振アンテナ１を実装した回路基板６１と複共振アンテナ５０を実装した回路基板６２を用意した。これらの回路基板６１，６２を計測順にファントム６３に近接して配置した。回路基板６１，６２の基板面を地面に垂直に立て、アンテナ１，５０を設置した部位の裏側の基板面とファントム６３の間隔を５ｍｍに設定した。また、回路基板６１，６２を地面に対し４５度傾けて設置した。なお、６４は回路基板６１，６２を計測位置に保持する支持具（疑似手）である。

【００４８】また、図１０を用いて回路基板６１，６２に対するアンテナ１，５０の設置位置を説明する。アンテナ１，５０は、給電電極５，５６側を回路基板６１，６２の短辺６１ａ，６２ａに向けて配置し、基体５２の幅寸法を考慮し、回路基板６１，６２の短辺６１ａ，６２ａに沿って左側の基板端６１ｂ，６２ｂからの距離が異なる３つの給電位置Ａ１，Ａ２，Ａ３を設定した。

【００４９】給電位置Ａ１は、単共振アンテナ１を回路基板６１の左側の基板端６１ｂに寄せたときの給電電極５の位置（Ａ１＝６ｍｍ）である。給電位置Ａ３は、回路基板６１，６２の短辺６１ａ，６２ａの中央（Ａ３＝２０ｍｍ）であり、この給電位置Ａ３は、単共振アンテナ１の給電電極５及び複共振アンテナ５０の給電電極５６を配置する位置である。また、給電位置Ａ２は、Ａ１とＡ３の中間の位置（Ａ２＝１３ｍｍ）である。

【００５０】測定に用いた周波数は１４８０ＭＨｚである。測定結果は次の表１の通りであった。

【００５１】

【表１】

| アンテナの種類 | 給電位置 | ファントム近傍利得（dBd） | | 帯域幅(MHz) VSWR<3 |
|---|---|---|---|---|
| | | 水平偏波 | 垂直偏波 | |
| 単共振 | A1 | -8.1 | -16.8 | 66.2 |
| | A2 | -7.6 | -15.3 | 48.9 |
| | A3 | -7.1 | -12.7 | 38.6 |
| 複共振 | A3 | -7.1 | -12.0 | 84.0 |

【００５２】この表１から明らかなように、単共振アンテナ１は、給電電極５を給電位置Ａ１からＡ３方向に移すに伴って、ファントム６３近傍に於ける利得が向上する。しかし、ＶＳＷＲ（電圧定在波比）が３未満となる

周波数帯域幅は、逆に狭くなる。これに対して、複共振アンテナ５０の給電電極５６を給電位置Ａ３に配置すると、単共振アンテナ１と比較して、利得は同等になるが、周波数帯域幅は２倍以上に広がる。この周波数帯域幅は、単共振アンテナ１の給電電極５を給電位置Ａ１に配置したときの周波数帯域幅よりも広くなっている。

【００５３】

【発明の効果】請求項１の無線通信機によれば、通信時に於ける表面実装型アンテナの内で電流が最も集中する部位を、基板電流が反対向きに流れる端辺の長さがほぼ等しくなる位置に配置するので、回路基板に流れる基板電流による表面実装型アンテナ近傍の電磁界が相殺され、或いは減衰され、使用者の影響を受けがたくし、アンテナ特性を安定にすることができる。

【００５４】また、表面実装型アンテナを回路基板の端辺略中央に設置したことにより、表面実装型アンテナの周波数帯域幅が狭くなるが、表面実装型アンテナの給電素子と無給電素子を複共振させるので、十分な周波数帯域幅を確保することができる。

【００５５】請求項２の無線通信機によれば、表面実装型アンテナの給電電極及びグランド電極を、回路基板の何れか１つの端辺の略中央部に配置するので、表面実装型アンテナの間近を流れる基板電流は相殺される。従って、使用者の影響を受けてアンテナ近傍の電磁界が乱れることによるアンテナ特性の劣化を緩和することができる。また、表面実装型アンテナは、給電素子と無給電素子を複共振させる構成であるので、表面実装型アンテナで使用する周波数帯域の帯域幅を広げることができる。

【００５６】請求項３の無線通信機によれば、表面実装型アンテナを容量給電により励振する場合でも、表面実装型アンテナの内で電流が最も強くなる給電素子と無給電素子のグランド電極を回路基板の１つの端辺の略中央部に配置するので、使用者の影響を受けてアンテナ近傍の電磁界が乱れることによるアンテナ特性の劣化を緩和し、同時に回路基板に於ける表面実装型アンテナから一定距離離れた部分を表面実装型アンテナの一部として働かせることができる。

【００５７】請求項４の無線通信機によれば、給電素子の第２高調波の共振周波数と無給電素子の共振周波数を複共振させるので、リターンロスの周波数特性に於いて、給電素子の基本波の周波数と第２高調波の周波数との間の整合の格差を緩和することができる。

【００５８】請求項５の無線通信機によれば、回路基板の端辺に沿った周囲長をλ／２以上の長さとしたので、回路基板を表面実装型アンテナの一部として機能させることができる。

【００５９】請求項６の無線通信機によれば、回路基板のグランド導体面に表面実装型アンテナを設置するので、表面実装型アンテナの動作を安定させることができる。

【図面の簡単な説明】

【図１】本発明に係る無線通信機に於ける表面実装型アンテナ実装部分の第１実施形態例を示す要部斜視図である。

【図２】図１の無線通信機に於ける表面実装型アンテナ実装部分を説明する平面図である。

【図３】図１の無線通信機の表面実装型アンテナに於けるリターンロスの周波数特性図である。

【図４】本発明に係る無線通信機に於ける表面実装型アンテナ実装部分の第２実施形態例を示す要部斜視図である。

【図５】図４に於ける表面実装型アンテナ実装部分の要部背面斜視図である。

【図６】図４の無線通信機の表面実装型アンテナに於けるリターンロスの周波数特性図である。

【図７】本発明に係る無線通信機に於ける表面実装型アンテナ実装部分の第３実施形態例を説明する平面図である。

【図８】本発明の無線通信機に係るアンテナ特性の測定に用いた表面実装型アンテナを示し、（Ａ）は表面斜視図、（Ｂ）は背面斜視図である。

【図９】本発明の無線通信機に係るアンテナ特性の測定条件を示す説明図である。

【図１０】本発明の無線通信機に係るアンテナ特性を測定するための表面実装型アンテナの実装位置を示す説明図である。

【図１１】従来の無線通信機に於ける表面実装型アンテナの実装形態を示す平面図である。

【図１２】従来の単共振の表面実装型アンテナを示す斜視図である。

【符号の説明】

１０，３０，５０　表面実装型アンテナ

１１，３１，４４，６１，６２　回路基板

１１ａ，１１ｂ，３１ａ，４４ｃ，４４ｄ，６１ａ，６２ａ　短辺

１１ｃ，１１ｄ，４４ａ，４４ｂ，６１ｂ，６２ｂ　長辺

１３，３２　給電素子

１４，３３　無給電素子

１５　入力端子

１６，３４，５３　給電放射電極

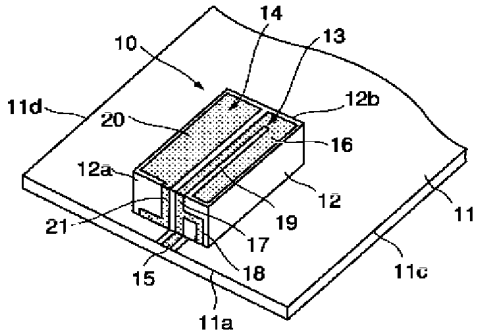
１７，４０，５６　給電電極

２０，３５，５４　無給電放射電極

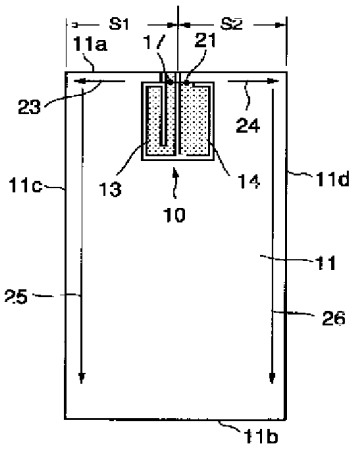
２１，３６，３７，４１，５８，５９　グランド電極

２３，２４，２５，２６，４５，４６，４７，４８　基板電流

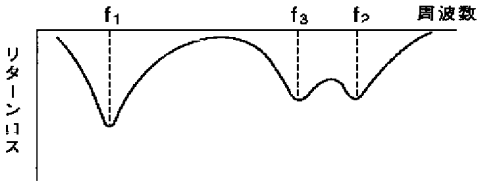
【図1】



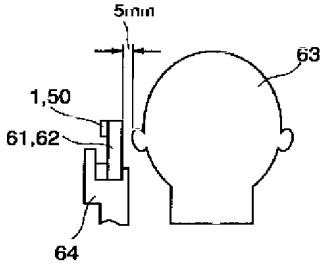

【図2】



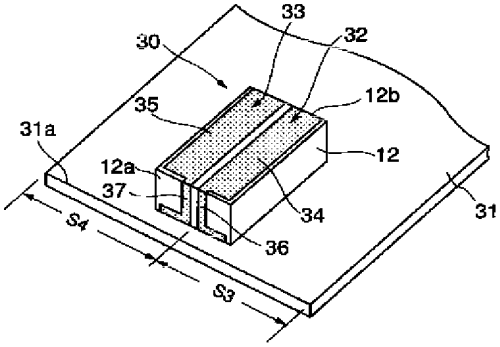

【図3】



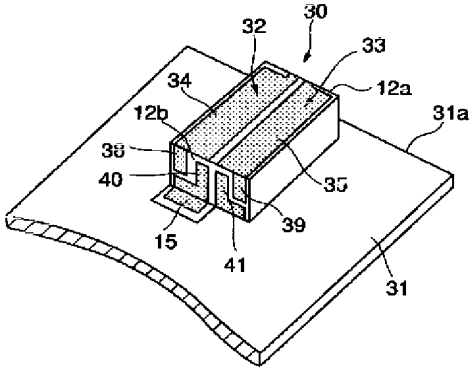

【図9】



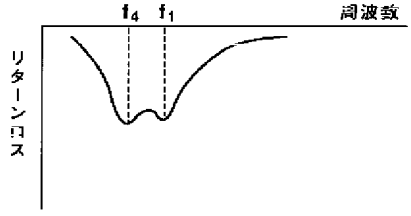

【図4】



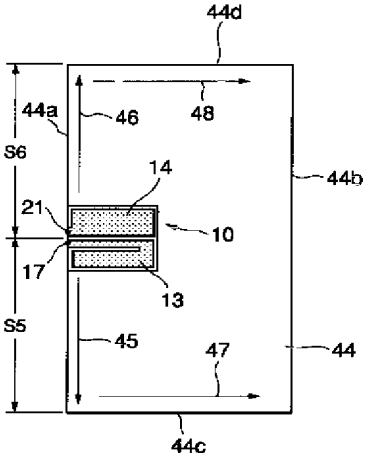

【図5】



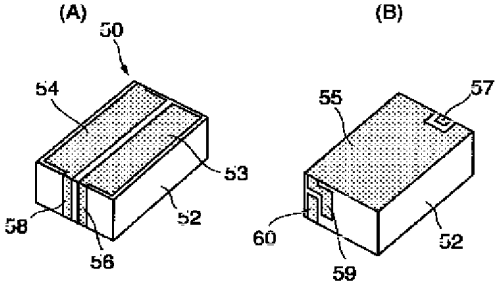

【図6】



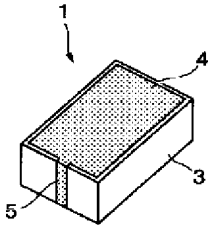

【図7】



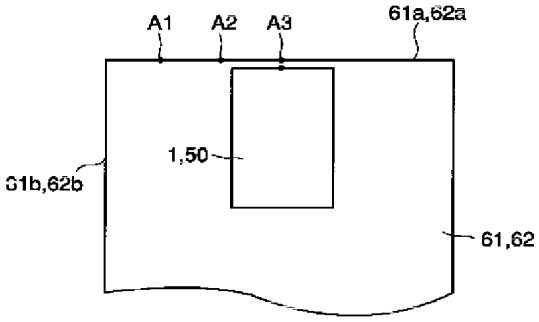

【図8】



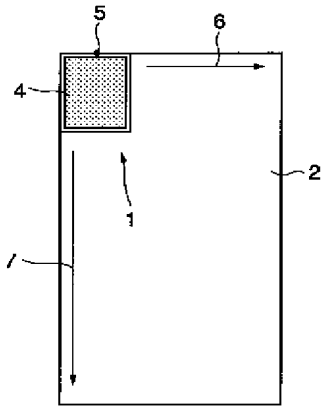

【図12】



【図１０】




【図１１】

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(72)発明者　佐藤　仁
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内

(72)発明者　南雲　正二
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内

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